CLAIMS

I claim:

1. An acoustic sensor, comprising:

a laminate including a piezoelectric transducer element having first and second faces, the laminate further including a matching layer assembly deployed on the second face of the transducer element;

the transducer element including conductive electrodes disposed on the first and second faces thereof; and

the matching layer assembly including at least one matching layer and a barrier layer, the barrier layer including a metallic material, the at least one matching layer being deployed between the transducer element and the barrier layer.

2. The acoustic sensor of claim 1, wherein the at least one matching layer comprises first and second matching layers, the first matching layer being deployed between the transducer element and the second matching layer.

3. The acoustic sensor of claim 2, wherein the first matching layer has an acoustic impedance in the range from about 8 to about 14 MRayl.

4. The acoustic sensor of claim 2, wherein the first matching layer comprises an epoxy resin.

5. The acoustic sensor of claim 4, wherein the first matching layer comprises a composite mixture of a ceramic material and the epoxy resin.

6. The acoustic sensor of claim 2, wherein the first matching layer comprises a ceramic material.

7. The acoustic sensor of claim 2, wherein the second matching layer has an acoustic impedance in the range from about 3 to about 7 Mrayl.

8. The acoustic sensor of claim 2, wherein the second matching layer comprises an epoxy resin.

9. The acoustic sensor of claim 2, wherein the second matching layer comprises a composite mixture of a ceramic material and an epoxy resin.

10. The acoustic sensor of claim 2, wherein the first matching layer and the second matching layer are formed from a single ceramic work piece.

11. The acoustic sensor of claim 10, wherein the ceramic work piece has a plurality of openings formed in one face thereof, the openings being filled with an epoxy resin.

12. The acoustic sensor of claim 11, wherein the openings are selected from the group consisting of holes, cuts, grooves, dimples, and indentations.

13. The acoustic sensor of claim 11, wherein the plurality of openings comprise from about 40 to about 80 volume percent of the second matching layer.

14. The acoustic sensor of claim 1, wherein the at least one matching layer comprises a single matching layer having an acoustic impedance that decreases from a relatively higher value at a first face of the matching layer to a relatively lower value at a second face of the matching layer.

15. The acoustic sensor of claim 14, wherein the single matching layer comprises a glass ceramic disk having a plurality of openings formed in one face of the matching layer, the openings being filled with an epoxy resin.

16. The acoustic sensor of claim 15, wherein the openings are tapered such that an area ratio of the epoxy resin to the glass ceramic increases from the first face to the second face.

17. The acoustic sensor of claim 1, wherein the metallic material is selected from the group consisting of stainless steel and titanium.

18. The acoustic sensor of claim 1, wherein the metallic material comprises titanium.

19. The acoustic sensor of claim 1, wherein the barrier layer has an acoustic impedance less than about 10 MRayl.

20. The acoustic sensor of claim 1 wherein the barrier layer is corrugated.

21. The acoustic sensor of claim 20, wherein said corrugated barrier layer is formed by a metal stamping process.

22. The acoustic sensor of claim 1, wherein the barrier layer comprises a composite material including a metallic work piece including opposing faces, the work piece having a plurality of openings formed in one face thereof, the plurality of openings being filled with an epoxy resin.

23. The acoustic sensor of claim 22, wherein the openings are selected from the group consisting of holes, cuts, and grooves.

24. The acoustic sensor of claim 22, wherein the openings comprise a plurality of concentric grooves.

25. The acoustic sensor of claim 1, wherein the barrier layer is welded to a sensor housing.

26. The acoustic sensor of claim 1, wherein the transducer comprises a piezo-ceramic transducer element.

27. The acoustic sensor of claim 1, wherein the transducer comprises a piezo-composite transducer element.

28. The acoustic sensor of claim 1, wherein the laminate further comprises a backing layer, the backing layer being deployed on the first face of the transducer element.

29. An acoustic sensor comprising:

a laminate including a piezoelectric transducer element having first and second faces, the laminate further including a matching layer assembly deployed on the second face of the transducer element;

the transducer element including conductive electrodes disposed on the first and second faces thereof; and

the matching layer assembly including at least one matching layer formed from a substantially planar ceramic work piece.

30. The acoustic sensor of claim 29, wherein the ceramic work piece has an acoustic impedance in the range from about 8 to about 14 MRayl.

31. The acoustic sensor of claim 29, wherein the at least one matching layer comprises first and second matching layers, the ceramic work piece including a plurality of openings formed in one face thereof, the plurality of openings being filled with an epoxy resin.

32. The acoustic sensor of claim 31, wherein the openings are selected from the group consisting of holes, cuts, grooves, dimples, and indentations.

33. The acoustic sensor of claim 31, wherein the plurality of openings comprise from about 40 to about 80 volume percent of the second matching layer.

34. The acoustic sensor of claim 29, wherein the at least one matching layer comprises a single matching layer having an acoustic impedance that decreases from a relatively higher value at a first face of the matching layer to relatively lower value at a second face of the matching layer.

35. The acoustic sensor of claim 34, wherein the ceramic work piece comprises a plurality of openings formed in one face thereof, the openings being filled with an epoxy resin.

36. The acoustic sensor of claim 35, wherein the openings are tapered such that an area ratio of the epoxy resin to glass ceramic increases from the first face to the second face.

37. An acoustic sensor comprising:

a laminate including a piezoelectric transducer element having first and second faces, the laminate further including a barrier layer deployed proximate the second face of the transducer element on an outermost surface of the laminate;

the transducer element including conductive electrodes disposed on the first and second faces thereof; and

the barrier layer including a metallic material.

38. The acoustic sensor of claim 37, wherein the metallic material comprises titanium.

39. The acoustic sensor of claim 37, wherein the barrier layer has an acoustic impedance less than about 10 MRayl.

40. The acoustic sensor of claim 37 wherein the barrier layer is corrugated.

41. The acoustic sensor of claim 38, wherein said corrugated barrier layer is formed by a metal stamping process.

42. The acoustic sensor of claim 37, wherein the barrier layer comprises a composite material including a metallic work piece having a plurality of openings formed in one face thereof, the plurality of openings being filled with an epoxy resin.

43. The acoustic sensor of claim 42, wherein the openings are selected from the group consisting of holes, cuts, and grooves.

44. The acoustic sensor of claim 42, wherein the openings comprise a plurality of concentric grooves.

45. A downhole measurement tool comprising:

a substantially cylindrical tool body;

at least one acoustic sensor deployed on the tool body, the acoustic sensor including a piezoelectric transducer element having first and second faces, the transducer element in electrical communication with an electronic control module via conductive electrodes disposed on each of said faces; and

the acoustic sensor further including a matching layer assembly deployed on the second face of the transducer element, the matching layer assembly including at least one matching layer and a barrier layer, the barrier layer including a metallic material, the at least one matching layer being deployed between the transducer element and the barrier layer.

46. A method for fabricating an acoustic sensor, the method comprising:

providing a piezoelectric transducer element including at least one face thereon;

deploying at least one matching layer on one of the at least one faces of the transducer element; and

deploying a barrier layer on one of the at least one matching layers, all of the at least one matching layers being deployed between the transducer element and the barrier layer, the barrier layer including a metallic material.